

REMARKS

Present Status of the Application

The Office Action mailed Jun 19, 2003 rejected all presently pending claims 1-5. Specifically, claims 2-4 are object to because of the following informalities: In line 5 of Claim 2, a space is needed between "and" and "a"; and in line 8, "and" is needed between "p-transistor" and "to". Claims 3 and 4 each need to be dependent from Claim 2 to correct for antecedent problems. Specifically, the Office Action rejected claims 1-5 under 35 U.S.C. 103(a), as being unpatentable over Gersbach (5,598,313). Applicants have amended claims 1-5 above to properly address aforementioned informalities and to clarify the claim scope. After entry of the foregoing amendments, claims 1-5 remain pending in the present application, and reconsideration of those claims is respectfully requested.

Summary of Applicant's Invention

The invention provides an over-voltage crowbar for lightning surge and ESD protection. The over-voltage crowbar comprises a Zener diode, a mirror amplifier, two resistors, a speed-up capacitor and a clamping transistor. Once the surge voltage induced to the input voltage terminal is higher than a Zener voltage, the mirror amplifier is driven to generate an amplified voltage. This amplified voltage works together with the speed-up capacitor to fully and fast turn on the clamping transistor. Two resistors are used for grounding the input of the mirror amplifier and the input of the clamping transistor

respectively to ensure that the mirror amplifier and the clamping transistor remain off in the normal condition. The over-voltage crowbar of the present invention can rapidly drive the clamping transistor to low impedance. Therefore, the sustenance rating for lightning surge and ESD in the integrated circuit can be effectively improved.

Discussion of Objections

In response to the Office Action, in lines 5 and 8 of Claim 2, "and" is accordingly added between "p-transistor" and "to", and a "space" is added between "and" and "a". The Examiner also indicated that Claims 3 and 4 each needs to be dependent from Claim 2. In response, Applicants have amended dependency of Claims 3 and 4 to be dependent from Claim 2. Applicants respectively submit that these objections have been properly addressed, and therefore should be withdrawn.

Discussion of Office Action Rejections

The Office Action rejected claims 1-5 under 35 U.S.C. 103(a), as being unpatentable over Gersbach (5,598,313). Applicants respectfully controvert the rejections for at least the reasons set forth below.

A preliminary discussion of the differences between the technology and structure disclosed in Gersbach and the present invention is appropriate.

Firstly, Gersbach disclosed ' Since dissipation transistor Q1 is very wide, it has a large drain to gate capacitance which serves to couple the transient voltage to gates "G" of

Q1 and **Q2**, turning the transistors on. Transistor **Q2** then turns on transistor **Q3** starting the regenerative action which locks the circuit on until the ESD transient has been dissipated through transistor **Q1'**. The protective operation of this circuit is initiated since the parasitic drain to gate capacitance of the transistor **Q1** introduces the ESD signal to the gates of transistors **Q1** and **Q2**. Transistors **Q1** and **Q2** will be driven by the ESD transient via the parasitic capacitance across the drain and the gate of the transistor **Q1**. The turn-on of the transistor **Q2** will turn on the transistor **Q4** and makes the current mirror built by transistors **Q2**, **Q3** and **Q4** to function. Unlike Gersbach's trigger method of using a parasitic capacitance of the transistor **Q1**, the present invention uses a Zener diode **51** for triggering the mirror amplifier **40**. A Zener diode can always be manufactured and controlled with a higher precision than parasitic components, such as the parasitic capacitance of the transistor **Q1** in Gersbach.

Second, the regenerative action disclosed by Gersbach is a positive feedback structure, which locks the circuit until the ESD transient is dissipated. On the contrary, the mirror amplifier **40** according to the present invention is constructed to act as an amplifier for providing an amplified voltage, for turning on the clamping transistor **69**. As soon as the induced ESD voltage is higher than the Zener voltage summed with the gate threshold voltage of the n-transistor **55**, the mirror amplifier **40** is triggered to promptly dissipate the ESD voltage. As the ESD voltage is lower than the Zener voltage, the mirror amplifier will soon be disabled. Unlike Gersbach's invention, the present invention doesn't suffer latch problem. Therefore, the present invention is both suitable for ESD and lightning

surge protections applications while Gersbach's invention is only suitable for ESD protection.

Last, according to the present invention, two resistors are respectively connected from the input of the mirror amplifier **40** and the gate of the clamping transistor **69** to the ground for ensuring the protection operation will not be affected by the noise spread in the system. This is not disclosed in Gersbach, therefore, Gersbach's invention suffers from low noise immunity.

For at least the foregoing reasons, Applicants respectfully submit independent claims **1** and **5** are patentable over the prior art. Claims **3**, **4** dependent on claim **2** are also patentable over the prior art.

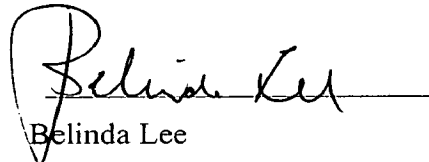
CONCLUSION

For at least the foregoing reasons, it is believed that the pending claims 1-5 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

Respectfully submitted,

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